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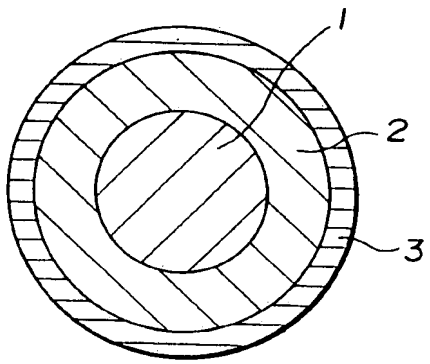
(54) Golf balls.

(57) In a three-piece solid golf ball comprising a center core, an intermediate layer, and a cover, the center core (1) has a diameter of at least 29 mm and a specific gravity of less than 1.4, the intermediate layer (2) has a thickness of at least 1 mm, a specific gravity of less than 1.2, and a hardness of at least 85 on JIS C scale, and the cover (3) has a thickness of 1-3 mm. The ball has a good total balance of properties in that feeling and controllability are improved at no sacrifice of flying performance and durability.

FIG.1



EP 0 633 043 A1

This specification relates to golf balls.

Prior Art

Among a variety of golf balls, thread-wound golf balls and solid golf balls are now popular. The solid golf balls are currently increasing to be a mainstream. Among them, two-piece solid golf balls consisting of a core and a cover are most widespread.

Most amateur golfers are fond of two-piece solid golf balls which have excellent flying performance and durability although these balls have the disadvantages of a very hard feel on hitting and low control due to rapid ball separation on hitting. For this reason, many of professional golfers and skilled amateur golfers who impose weight on feeling and control prefer wound golf balls, especially wound golf balls using a soft balata cover, to two-piece solid golf balls. The wound golf balls are superior in feeling and control, but inferior in flying distance and durability to the two-piece solid golf balls.

Under the present situation that two-piece solid golf balls and wound golf balls have contradictory characteristics as mentioned above, players make a choice of golf balls depending on their own skill and taste.

In order to develop solid golf balls having a hitting feel approximate to the wound golf balls, two-piece solid golf balls of soft type have been considered. For such two-piece solid golf balls of soft type, soft cores must be used. If the cores are soft, however, repulsion becomes low with a concomitant loss of flying performance and durability is considerably deteriorated. That is, the superior flying performance and durability which are characteristic of two-piece solid golf balls are lost, and in an extreme case, the balls become unacceptable for practical use.

Controllability, which is required even on full shots with drivers, is most important on control shots like approach shots. In an exemplary situation that the next shot should fly beyond the bunker and a short distance from the green edge to the cup, the player who is either professional or amateur will naturally wish to hit a ball with a minimal run. Such controllability of a golf ball largely depends on spin properties.

On a full shot with a club having a relatively large loft, the club loft is more dominant than the ball itself so that almost all balls are given an appropriate amount of spin and few balls overrun. However, on a approach shot over a short distance of 30 or 50 yards, balls will significantly vary in run or controllability. The major factor causing such a difference is not a basic structure, but the identity of cover material. In two-piece solid golf balls, however, covers made of soft material are effective for improving controllability but detrimental for gaining flying distance.

An aim herein is to provide a novel and useful solid golf ball construction. A preferred aim is to achieve a good feel and controllability while maintaining the good flying performance and durability which are characteristic of solid golf balls.

In connection with a solid golf ball having a core forming the center and a cover forming the outermost layer, we have found that by providing a relatively hard intermediate layer between the center core and the cover,

the center core can be made relatively soft so as to improve feeling and controllability without deteriorating flying performance and durability. The feeling and controllability can be improved in a favorable way.

Preferably the dimensions and densities of these elements are adjusted as follows. An intermediate layer having a thickness of at least 1 mm, a specific gravity of less than 1.2, and a hardness of at least 85 on JIS C scale is formed around a center core having a diameter of at least 29 mm and a specific gravity of less than 1.4 and greater than the intermediate layer specific gravity and a cover having a thickness of 1 to 3 mm is formed on the outer surface of the intermediate layer to complete a solid golf ball. Then even when the center core is softened to a JIS C scale hardness of 45 to 80 and the cover softened to a JIS C scale hardness of 50 to 85, good feeling and controllability can be achieved with little or no loss of flying distance and durability. Further when the intermediate layer is formed of a resin composition based on a high repulsion ionomer resin, the hitting feel and controllability can be further improved with little or no loss of flying distance and durability.

A specific proposal herein is therefore a three-piece solid golf ball comprising a center core, an intermediate layer, and a cover wherein the center core has a diameter of at least 29 mm and a specific gravity of less than 1.4, the intermediate layer has a thickness of at least 1 mm, a specific gravity of less than 1.2, and a hardness of at least 85 on JIS C scale, and the cover has a thickness of 1 to 3 mm. The specific gravity of the intermediate layer is lower than the specific gravity of the center core. In one preferred embodiment, the intermediate layer is formed of a composition based on a high repulsion ionomer resin.

BRIEF DESCRIPTION OF THE DRAWING

The only figure, FIG. 1 is a schematic cross section of a three-piece solid golf ball.

EXPLANATIONS; PREFERRED AND OPTIONAL FEATURES

Referring to FIG. 1, there is schematically illustrated a typical three-piece solid golf ball embodying our new concepts. The ball includes a spherical center core 1 forming the center of the ball and a cover 3 forming the outermost layer of the ball. A relatively hard intermediate layer 2 is disposed between the core 1 and the cover 3. The size and specific gravity of the core 1, intermediate layer 2, and cover 3 are preferably in the specific ranges explained below (which may be selected individually, independently of one another).

The center core generally has a diameter of at least 29 mm, preferably 29 to 37 mm and a specific gravity of less than 1.4, preferably 1.05 to 1.38. With a diameter of less than 29 mm, the intermediate layer must be relatively thick with losses of repulsion and feeling. With a specific gravity of 1.4 or more, the ball has a heavier weight which may exceed the weight requirement for golf balls.

On an impact entailing substantial deformation as found on driver shots, the player gets a feeling which largely depends on the hardness of the center core 1 and varies with the club head speed given by the player. Therefore, the hardness of the center core 1 should be set in accordance with the head speed of the target players. In this sense, the center core hardness is not particularly limited although it preferably ranges from 45 to 80, more preferably from 60 to 80 on JIS C scale (at the center core surface).

The center core 1 may be formed from a well-known rubber composition comprising a base rubber, co-crosslinking agent and peroxide through heating, pressing and molding steps. The base rubber may be one conventionally used in solid golf balls and preferably is selected from polybutadiene rubber and mixtures of polybutadiene rubber and polyisoprene rubber. Use of 1,4-polybutadiene rubber containing more than 90% of cis structure is preferred for high repulsion. The co-crosslinking agents used in conventional solid golf balls include zinc and magnesium salts of unsaturated fatty acids such as methacrylic acid and acrylic acid and esters of unsaturated fatty acids such as trimethyl-propane trimethacrylate and they may be used.

Zinc acrylate is preferred for high repulsion. The co-crosslinking agent is blended in amounts of about 15 to 30 parts by weight per 100 parts by weight of the base rubber. The peroxide may be selected from a variety of peroxides, preferably dicumyl peroxide and mixtures of dicumyl peroxide and 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane. The peroxide is blended in amounts of about 0.5 to 1 part by weight per 100 parts by weight of the base rubber. If desired, zinc oxide and barium sulfate may be blended in the rubber composition for specific gravity adjustment while antioxidants may also be blended.

The intermediate layer 2 generally has a radial thickness of at least 1 mm, preferably 1.5 to 3.5 mm, a specific gravity of less than 1.2, preferably 0.9 to 1 and lower than the center core specific gravity, and a hardness of at least 85, preferably 85 to 100 on JIS C scale. With a thickness of less than 1 mm, repulsion is lowered to reduce flying distance. With a specific gravity of 1.2 or more, the center core must have a relatively low specific gravity so that the golf ball may be increased in inertia moment and reduced in spin property and thus lose some controllability. Similar detrimental effect is observed when the intermediate layer specific gravity is greater than the center core specific gravity. A layer with a JIS C scale hardness of less than 85 detracts from flying performance. The intermediate layer preferably has an outer diameter of 38 to 41 mm though not limited thereto. Also preferably the difference in specific gravity between the center core and the intermediate layer is 0.1 or more, especially 0.1 to 0.5 though not limited thereto.

The intermediate layer 2 can be effective in compensating for lower repulsion of the center core 1 which is made soft. It may be formed of a relatively hard (JIS C scale hardness $\geqq$ 85), repulsive material. Although the material is not critical, ionomer resins are preferred e.g. having the compositions of Himilan® 1706 or 1605 (commercially available from Mitsui-duPont Polychemical K.K.) or of Surlyn® (commercially available from E.I. du Pont). A 1:1 blend of Himilan 1706 and Himilan 1605 is most preferred. In addition to the ionomer resin, the composition of which the intermediate layer is formed may further contain weight control agents, for example, inorganic fillers such as zinc oxide and barium sulfate, coloring agents such as titanium dioxide, and other additives. The cover 3 generally has a radial thickness of 1 to 3 mm, preferably 1.5 to 2.5 mm. A cover of more than 3 mm thick is low in repulsion whereas a cover of less than 1 mm thick is low in durability such as cut resistance. Although the hardness of the cover 3 is not particularly limited, it is preferably set in a relatively soft range of 50 to 85, more preferably 60 to 85 on JIS C scale because in this range, good properties in all of repulsion (flying performance), durability and controllability are expected.

The cover 3 may be formed of resinous materials which are conventionally used as the cover of solid golf balls, preferably those materials which are relatively soft (JIS C scale hardness 50 to 85) and highly repulsive. Examples include ionomer resins such as Himilan® 1650 commercially available from Mitsui-duPont Polychemical K.K., Surlyn® 8120 commercially available from E.I. duPont, and mixtures thereof, thermoplastic polyester elastomers such as Hytrel® 4047 commercially available from Toray-duPont K.K., and balata resins. If necessary, inorganic fillers may be blended in these resins for coloring purposes.

EXAMPLE

Examples of the present invention are given below by way of illustration and not by way of limitation.

Examples and Comparative Examples

Using a center core, intermediate layer, and cover having the composition shown in Table 1, three-piece solid golf balls (Examples 1-6, Comparative Examples 1-3) were prepared. The center core was prepared by kneading the respective components in a roll mill and pressure molding at 155°C for 15 minutes. The intermediate layer was formed by injection molding so as to enclose the outer surface of the center core. The cover was formed around the intermediate layer by injection molding. The three-piece solid golf balls were completed in this way. The parameters associated with the core, intermediate layer and cover are shown in Table 2.

The golf balls were evaluated for spin characteristic, flying performance, feeling, and durability by the following tests. The results are shown in Table 2.

Spin characteristic

Using a swing robot manufactured by True Temper Co., the ball was hit by the driver at a head speed of 45 m/s (abbreviated as W1 HS45 in Table 2) and by the sand wedge at a head speed of 17.6 m/s (abbreviated as SW HS17.6 in Table 2). The ball spin (rpm) was observed using a science eye (manufactured by Bridgestone Corporation).

Feeling

Professional golfers evaluated a feeling on impact according to the following criterion.

- ○: good
- Δ: average
- ×: poor

Flying performance

In the spin and feeling tests, the flying distance the ball traveled was also measured. Total evaluation was made according to the following criterion.

- ○: good
- Δ: average
- ×: poor

Durability

Using a flywheel hitting machine, the ball was repeatedly hit at a head speed of 38 m/s until the ball was broken. With the number of hits counted, the ball was rated according to the following criterion.

- ○: good
- Δ: average
- ×: poor

Table 1

	Example						Comparative Example		
	1	2	3	4	5	6	1	2	3
Center core									
Cis – 1,4 – polybutadiene	100	100	100	100	100	100	100	100	100
Zinc acrylate	20	20	20	30	20	20	20	25	20
Zinc oxide	56	36	36	20	23	10	90	25	55
Antioxidant	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Dicumyl peroxide	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Intermediate layer									
Himilan 1706	50	50	50	50	50	50	50	50	50
Himilan 1605	50	50	50	50	50	50	50	50	50
Cover									
Himilan 1650	50	50	50			50	50		50
Surlyn 8120	50	50	50			50	50		50
Hytrel 4047				100				100	
Trans – isoprene rubber					90				
Natural rubber					10				

Note:

The amounts of components blended are parts by weight and their proportion is independent among the center core, intermediate layer, and cover.

EP 0 633 043 A1

Table 2

	Example						Comparative Example		
	1	2	3	4	5	6	1	2	3
Center core									
Outer diameter, mm	31.52	35.28	35.28	35.28	35.29	36.40	27.68	35.24	31.52
Hardness, JIS C	66	66	66	79	66	66	66	73	66
Specific gravity	1.36	1.24	1.24	1.19	1.16	1.07	1.56	1.19	1.35
Intermediate layer									
Thickness, mm	3.4	1.7	2.2	2.2	1.7	2.0	5.7	1.8	1.6
Hardness, JIS C	91	91	91	91	91	91	91	82	91
Specific gravity	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.97	0.95
Outer diameter, mm	38.35	38.73	39.65	39.66	38.73	40.40	39.00	38.91	34.56
Cover									
Thickness, mm	2.2	2.0	1.5	1.5	2.0	1.8	1.8	1.9	4.0
Specific gravity	0.97	0.97	0.97	1.10	1.13	0.97	0.97	1.10	0.97
Hardness, JIS C	82	82	82	61	78	82	82	61	82
Ball									
Outer diameter, mm	42.68	42.67	42.67	42.70	42.70	44.00	42.65	42.63	42.65
Weight, g	45.50	45.45	45.50	45.55	45.53	45.60	45.50	45.55	45.50
Performance									
Spin (rpm) W1 HS45	3300	3020	3030	3920	3600	3030	3500	3600	3250
SW HS17.6	3900	4000	4300	6390	5800	4100	4100	4050	3500
Feeling	△	○	○	△	○	○	×	○	○
Flying performance	○	○	○	○	△	○	×	×	×
Durability	○	○	○	○	○	○	○	○	○

As is evident from Table 2, the three-piece solid golf balls, and particularly those with the preferred selected dimensions and densities etc. of their components, had a good balance of properties in that the center core and cover can be made soft so as to ensure a pleasant feeling and controllability (spin) without deteriorating flying performance and durability.

There has been described a three-piece solid golf ball which includes a core, intermediate layer and cover having controlled size, hardness and specific gravity so that the ball has a good total balance of properties in that a relatively soft center core and cover are used to ensure a pleasant feeling and controllability at no sacrifice of flying performance and durability.

Japanese Patent Application No. 5-193065 is incorporated herein by reference.

Although some preferred embodiment have been described, many modifications and variations may be made thereto in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

Claims

1. A three-piece solid golf ball comprising a center core, an intermediate layer, and a cover enclosing the core through the intermediate layer,

   said center core having a diameter of at least 29 mm and a specific gravity of less than 1.4,

   said intermediate layer having a thickness of at least 1 mm, a specific gravity of less than 1.2, and a hardness of at least 85 on JIS C scale, the specific gravity of said intermediate layer being lower than the specific gravity of said center core, and

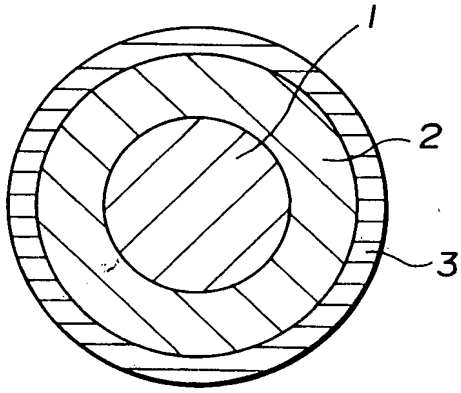
   said cover having a thickness of 1 to 3 mm.

2. The golf ball of claim 1 wherein said intermediate layer is formed of a high repulsion ionomer resin base composition.

3. The golf ball of claim 1 wherein said center core has a hardness of 45 to 80 on JIS C scale and said cover has a hardness of 50 to 85 on JIS C scale.

4. The golf ball of claim 1 wherein said center core is comprised of a polybutadiene base rubber composition.

FIG.1



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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 5042

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	GB-A-2 228 874 (SUMITOMO RUBBER INDUSTRIES LTD) * page 2, line 23 - page 5, line 31; claims * ---	1-4	A63B37/00
A	GB-A-2 232 162 (SUMITOMO RUBBER INDUSTRIES LTD) * abstract; figures * ---	1	
A	GB-A-2 185 890 (KAMATARI CO. LTD) * abstract; claims * ---	1	
A	FR-A-2 666 018 (SALOMON (S.A.)) * abstract * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

A63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 October 1994	Giménez Burgos, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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